EPIDEMIOLOGY/HEALTH SERVICES RESEARCH

Long-term Effects of Disasters on Seniors With Diabetes: Evidence From Hurricanes Katrina and Rita

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OBJECTIVE

To estimate the long-run mortality effects of Hurricanes Katrina and Rita on seniors with diabetes.

RESEARCH DESIGN AND METHODS

We performed a retrospective cohort analysis of Medicare enrollment and claims data covering four states and ∼10 years. Affected individuals were identified by whether they lived in a county that suffered a high impact and were stratified by whether they moved to a different county following the storms. Propensity scores matched affected and comparison subjects based on demographic and socioeconomic characteristics and the presence of chronic conditions. Our sample consisted of 170,328 matched affected subjects.

RESULTS

The affected subjects had a nearly 40% higher all-cause mortality risk in the 1st month after the storms, but the difference fell to <6% by the end of the full observation period. The mortality risks of heart disease and nephritis also exhibited the largest differences immediately following the storms. Among the affected subjects, the all-cause mortality risk was higher for those who moved to a different county, with an especially large difference among those who moved to an affected county.

CONCLUSIONS

The propensity matching procedure resulted in the comparison and affected groups having similar observable characteristics. However, we only examined the extreme outcome of mortality, our definition of affected was somewhat crude, and our sample did not include individuals enrolled in Medicare Advantage. Our findings highlight the importance of the immediate response to disasters, yet also demonstrate the long-lasting impact disasters can have.

Disasters can pose severe immediate challenges to individuals with diabetes, including disrupted access to health care providers, difficulty in obtaining proper nutrition, damaged or lost medications, and challenges in monitoring glucose levels (1). However, the longer-term effects of disasters are less understood. Generally, less attention is paid to effects from disasters as time passes. Further, it is difficult to associate outcomes with disasters significantly later due to challenges in obtaining complete longitudinal data and the occurrence of confounding events.

However, there may be significant long-term effects of disasters on those with diabetes. Some individuals may not recover from the initial impact due to the trauma.

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They may not resume management of their condition due to the effort required to recover in other aspects of their lives. Outside of disasters, care interruptions and medical nonadherence are associated with more emergency department visits and hospitalizations both in the short- (2–4) and long-term (1–8). Further, the potential effects may vary depending on whether an individual was displaced by the event. For example, the need to establish a new health care support system may hinder the ability to receive appropriate care (9).

Previous research has explored the short-term effects of disasters on those with diabetes. Victims of Hurricane Katrina with diabetes were found to have elevated A1C, blood pressure, and lipid levels soon after the storm (10), but 1 year later many of the measures had recovered (11). Dialysis patients impacted by Katrina had higher hospitalization rates (12) but not 6-month mortality risk (13). Seniors with diabetes had reduced rates of maintenance screens following the storm (14). Individuals with diabetes in areas impacted by Superstorm Sandy had higher emergency department visit and hospitalization rates (1,15,16).

On 29 August 2005, Hurricane Katrina made landfall at southeast Louisiana as a Category 3 hurricane. The storm was directly responsible for 1,200 deaths (17), while ~1.5 million people in the Gulf of Mexico region were forced to evacuate (18). Less than 4 weeks later, Hurricane Rita came ashore in southwest Louisiana on 24 September 2005, also as a Category 3 storm. While only directly responsible for seven deaths (19), Rita caused 18.5 billion USD in damages (20).

This study uses individual-level data on seniors with diabetes to examine the association between exposure to Hurricanes Katrina and Rita and mortality risk for nearly 10 years after the storms.

RESEARCH DESIGN AND METHODS

Study Design and Setting

We performed a retrospective cohort study comparing short- and long-term mortality risk for seniors with type 1 and type 2 diabetes affected by Hurricanes Katrina and Rita with those who were not. We also investigated potential differential effects depending on whether the individual was displaced and, if so, to where. Our observation period is December 2004 through December 2014.

The study was approved on an expedited basis by the institutional review board at the University of South Florida.

Study Cohort

We employed data regarding Medicare enrollment and claims from 2004 through 2014. The data were obtained via an application to the Research Data Assistance Center and accessed via the Centers for Medicare and Medicare Services' Virtual Research Data Center. The prematched population was initially defined as Medicare beneficiaries living in Louisiana, Mississippi, Texas, or Alabama in 2005 who were classified as having diabetes. The classification criteria were having a diabetes diagnostic code in either one inpatient, skilled nursing, or home health agency claim or in two hospital outpatient or physician claims (21). Additional criteria, described in Supplementary Fig. 1, excluded beneficiaries who were enrolled due to disability status and those who were not enrolled in both Part A and Part B coverage in every month of the observation period in which they were alive. The resulting 547,873 subjects comprised the prematched population.

The comparison and affected groups were based on the subject's county of residence at the end of 2004, the latest reported date before the hurricanes. Following major disasters, the Federal Emergency Management Agency (FEMA) can declare counties most affected by the disaster to be entitled to Individual Assistance, which provides help to individuals and households. For our analysis, the affected groups were defined as individuals residing in counties designated as Individual Assistance following either Hurricane Katrina or Rita. Supplementary Fig. 2 contains a map that indicates the designated counties.

The index date of 29 August 2005 was based on the landfall of Hurricane Katrina. Subjects were followed until death or the end of our observation period, 31 December 2014, leading to varying lengths of follow-up. The outcome of interest was death. Information regarding death was obtained from a linkage between the Medicare enrollment data and the National Death Index. While all-cause mortality data were available through 2014, reliable data regarding cause of death were only available through 2006. The three cause of death categories analyzed were diabetes, major cardiovascular disease, and the grouping of nephritis, nephrotic syndrome, renal failure, and other disorders of the kidney (hereafter referred to collectively as nephritis) (Supplementary Table 1 details the category definitions).

Baseline characteristics included demographic information and the presence of chronic conditions. The Chronic Conditions segment of the Medicare enrollment data were used to identify the presence of chronic conditions. These data are derived using claims-based algorithms and reflect service patterns that correspond to an individual receiving treatment for the condition (22,23).

Statistical Methods

To balance the covariates between the comparison and affected groups, one-to-one propensity matching for whether the individual resided in an affected county was employed using the baseline variables listed in Table 1. The matching was performed without replacement. While a common support was enforced and we used a caliper measure employed by Austin (24) (2011), no affected subjects were lost. When alternative caliper measures were used in matching of the full sample, the largest number of dropped affected subjects was 46, and thus our results were largely unaffected. Differences in baseline characteristics were assessed by the calculation of the absolute standardized differences in variables across the two groups. Values of <10% were considered nonsignificant.

Mortality hazards of the comparison and treated groups were graphically analyzed. Cumulative hazard functions were estimated for all-cause mortality. For each specific cause, cumulative subhazard functions that accounted for the competing risks of other mortality causes were estimated. Crude mortality rates per 100,000 person-years were estimated for the prematched and postmatched populations for the 1-month, 1-year, 5-year, and full observation periods.

The effects of residing in an affected area were initially estimated via hazard ratios. However, the Schoenfeld test following the all-cause mortality estimation indicated that the proportional hazards assumption was violated and that

Table 1—Baseline data from the postmatched population

	Control group	Affected group	Absolute standardized difference
n	170,328	170,328	
Enrollee characteristics			
Age, years	76.0 (6.9)	76.1 (6.9)	1.7
Female sex, *n* (%)	99,604 (58.4)	99,904 (58.7)	0.4
Race/ethnicity, *n* (%)			
White	123,030 (72.2)	122,557 (72.0)	0.6
Black	37,714 (22.1)	38,185 (22.4)	0.7
Hispanic	6,643 (3.9)	6,643 (3.9)	0.0
Asian	2,093 (1.2)	2,075 (1.2)	0.1
Other	848 (0.5)	868 (0.5)	
Medicaid premiums, months*	2.5 (4.8)	2.6 (4.9)	2.4
ESRD coverage, *n* (%)	3,070 (1.8)	3,176 (1.9)	0.5
Chronic condition, *n* (%)			
Acute myocardial infarction	8,950 (5.3)	9,415 (5.5)	1.2
Alzheimer disease	13,157 (7.7)	14,033 (8.2)	1.9
Alzheimer disease and related disorders or senile dementia	26,672 (15.7)	28,395 (16.7)	2.7
Atrial fibrillation	26,421 (15.5)	27,191 (16.0)	1.2
Anemia	86,023 (50.5)	87,620 (51.4)	1.9
Asthma	15,131 (8.9)	15,663 (9.2)	1.1
Cancer, breast†	7,410 (4.4)	7,689 (4.5)	0.8
Cancer, colorectal	5,153 (3.0)	5,482 (3.2)	1.1
Cancer, prostate	9,245 (5.4)	9,354 (5.5)	0.3
Cancer, lung	1,668 (1.0)	1,808 (1.1)	0.8
Cancer, endometrial	887 (0.5)	916 (0.5)	0.2
Cataract	104,990 (61.6)	104,651 (61.4)	0.4
Chronic kidney disease	32,327 (19.0)	33,512 (19.7)	1.8
Chronic obstructive pulmonary disease and bronchiectasis	44,345 (26.0)	45,950 (27.0)	2.1
Congestive heart failure	67,358 (39.5)	68,974 (40.5)	1.9
Depression	37,934 (22.3)	39,587 (23.2)	2.3
Glaucoma	33,156 (19.5)	33,875 (19.9)	1.1
Hip/pelvic fracture	5,399 (3.2)	5,841 (3.4)	1.4
Hyperlipidemia	119,122 (69.9)	118,618 (69.6)	0.7
Benign prostatic hyperplasia	26,053 (15.3)	26,033 (15.3)	0.0
Hypertension	155,251 (91.1)	155,274 (91.2)	0.0
Acquired hypothyroidism	35,515 (20.9)	36,306 (21.3)	1.1
Ischemic heart disease	98,741 (58.0)	99,601 (58.5)	1.0
Osteoporosis	22,309 (13.1)	23,355 (13.7)	1.7
Rheumatoid arthritis/osteoarthritis	79,294 (46.6)	80,824 (47.5)	1.8
Stroke/transient ischemic attack	33,963 (20.0)	35,242 (20.7)	1.9

Data are means (SD) for continuous variables and frequencies (percent) for categorical variables. The absolute standardized difference is the absolute value of the difference of the sample means for the two groups divided by the mutual SD. Values of <10 are considered nonsignificant. Postmatched population based on one-to-one matching with caliper of 0.1175. All variables measured as of 31 December 2004. ESRD, end-stage renal disease. *Medicaid premiums represent the number of months in 2004 where the state Medicaid agency paid the individual's Medicare premium. †Includes male and female breast cancer.

the hazard varied significantly during the full observation period. Similarly, the test for proportional hazards in the estimations for cardiovascular mortality also was rejected.

Given the results of the proportional hazards tests, conditional logistic regressions were used to estimate the effects of residing in an affected area. The dependent variable was an indicator as to whether the subject died during the observation period. Separate models were estimated by mortality cause and observation period. Odds ratios were calculated, and CIs were based on robust Abadie-Imbens SEs. Six separate all-cause models were estimated corresponding to observation periods of 1 month, 6 months, 1 year, 3 years, and 5 years and for the full observation period. Three separate by-cause models were estimated for 1-month, 6-month, and 1-year observation periods. Estimations were performed in Stata15 using the clogit command.

For investigation of the possible effects of individuals being displaced after the hurricanes, additional models were estimated in which the sample was subset by the county in which the affected subject lived at the end of 2005 or at the time of death—whichever came first. The subjects were initially divided by whether they resided in the same county at the end of 2004 and 2005. Those who did not were then further subset by whether they had moved to an affected or unaffected county. For each of the subset samples, the treated subjects were matched with subjects in the comparison group before the regression was estimated.

RESULTS

Baseline Patient Characteristics

Table 1 details the characteristics of the matched subjects as of the end of 2004. Our full prematched population consisted of 377,545 subjects in the comparison group and 170,328 in the affected group. No subjects in the affected group were lost in the matching procedure for all affected subjects or in the matching procedures for the subsets based on county of residence. The matching resulted in very similar distributions of propensity scores in the comparison and affected groups.

For the prematched population, most variables other than racial proportions are in good balance. Matching improves the balance significantly such that the largest absolute standardized difference was 2.7%, which is well below the 10% threshold. There were more females than males in the postmatched population, while whites and blacks comprised the vast majority of race/ethnicity values. Roughly 19% of the postmatched population had chronic kidney disease, while ~70% had hyperlipidemia.

Mortality Hazard Functions

Figure 1 contains the graph of the cumulative hazard functions for all-cause mortality and the proportional hazards functions for the three by-cause categories for the postmatched population. The all-cause functions indicated that the mortality risk was higher for the affected group, but the near linearity of both functions suggested that the difference was present early and was relatively constant throughout the observation period. The by-cause graphs also indicated higher risks in the affected group, with the largest difference for nephritis.

Crude Mortality Rates

The crude all-cause mortality rates shown in Table 2 were higher in the affected group for each of the specified observation periods. However, the gap between the affected and comparison rates decreased as the observation period was lengthened. The rates for heart disease and nephritis were greater for the affected group, but again the difference decreased when the observation period was increased. The diabetes mortality rates for the affected and comparison groups did not differ across either of the two observation periods.

Mortality Odds Ratios

The top section of Table 3 reports the mortality odds ratios for all subjects in the postmatched population. The ratios for all-cause mortality and the three by-cause categories were highest for the 1-month observation period. The all-cause mortality ratios decreased as the observation period was extended to 3 years and then were relatively constant for the other observation periods. The nephritis ratios were the highest among the mortality categories. The diabetes ratios only differed from 1 in the 1-year observation period and were slightly <1.

The bottom section of Table 3 subsets the affected subjects by the county in which they lived at the end of 2005. Some caution is warranted in interpreting the odds ratios based on a 1-month observation period for those who moved to another county. Especially given the

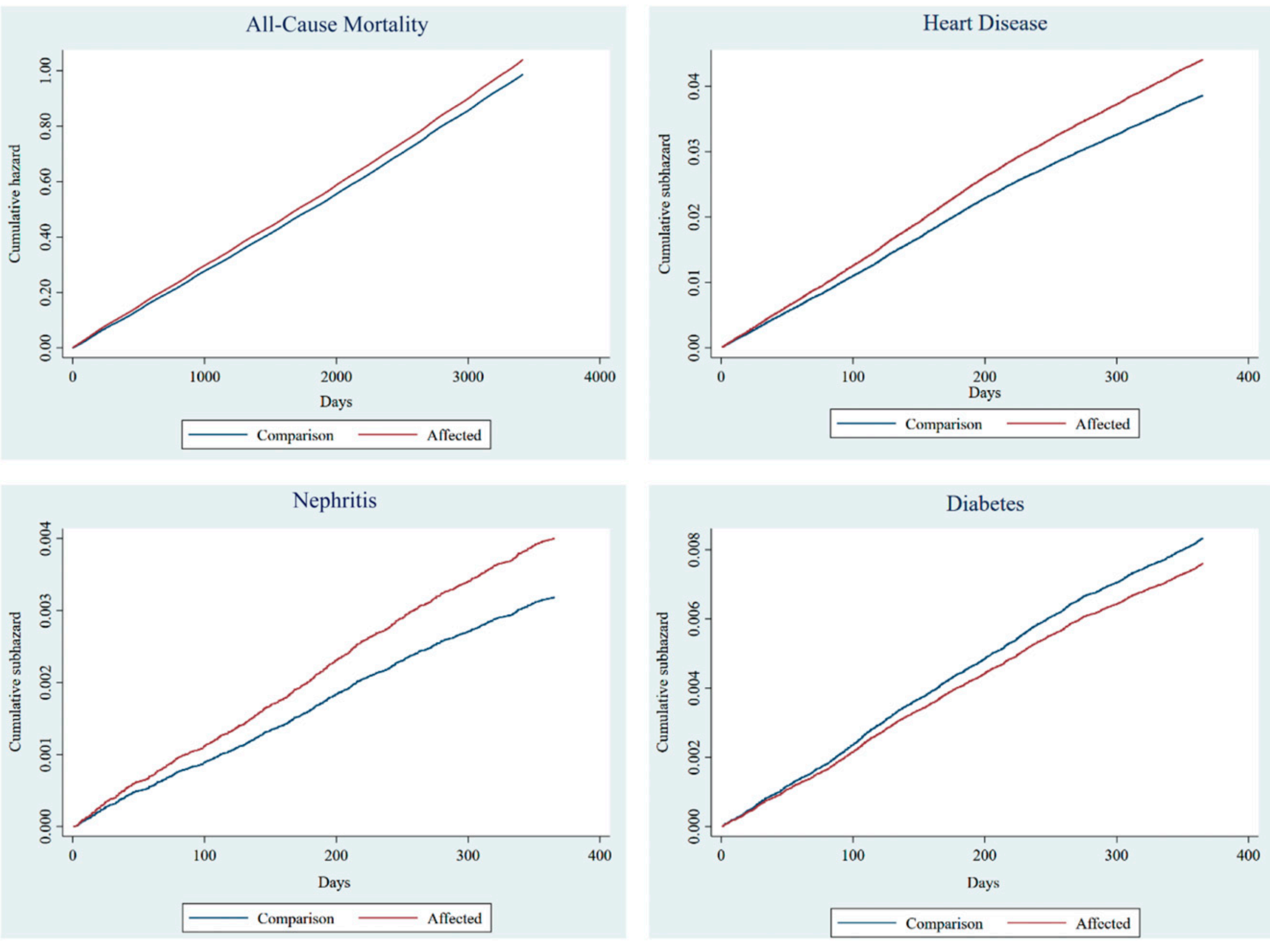

Figure 1—Cumulative mortality hazard function for all-cause mortality and subhazard functions for heart disease, nephritis, and diabetes.

Table 2—Crude mortality rates in the postmatched population

	1-month observation period		1-year observation period		5-year observation period		Full observation period	
	Comparison	Affected	Comparison	Affected	Comparison	Affected	Comparison	Affected
n	170,328	170,328	170,328	170,328	170,328	170,328	170,328	170,328
All cause	8,747 (8,272; 9,222)	12,195 (11,633; 12,757)	9,923 (9,770; 10,076)	11,150 (10,987; 11,313)	10,087 (10,011; 10,163)	10,717 (10,638; 10,796)	10,427 (10,364; 10,490)	11,014 (10,949; 11,079)
Diabetes	787 (644; 930)	849 (701; 997)	870 (825; 915)	800 (756; 844)	N/A	N/A	N/A	N/A
Heart disease	3,627 (3,321; 3,933)	4,894 (4,538; 5,250)	3,972 (3,875; 4,069)	4,556 (4,452; 4,660)	N/A	N/A	N/A	N/A
Nephritis*	316 (226; 406)	499 (385; 613)	333 (305; 361)	422 (390; 454)	N/A	N/A	N/A	N/A

Data are crude mortality rates per 100,000 person-years (CI). CIs are exact Poisson intervals at a 95% level. Observation periods begin on 28 August 2005. Full sample corresponds to period through 31 December 2014. N/A, estimates not available, as cause of death data were only available for the 1st year of the observation period. *Includes nephritis, nephrotic syndrome, and nephrosis.

logistical challenges following Hurricane Katrina, the addresses of those who died within a month of the hurricane may not have been revised to reflect a move away from an affected area.

The vast majority of subjects did not move to another county, and, not surprisingly, their odds ratios were very similar to those for all subjects. However, the odds ratios for those who moved followed a different pattern. The ratios for observation periods >1 month were larger than the corresponding values for those who did not move, and the largest ratio corresponded to the full observation period. The last two rows of the table further subset the subjects by whether they moved to another affected county. The point estimates of the ratios for the subjects who moved to another affected county were larger for all sample periods.

We performed several sensitivity analyses. We estimated adjusted odds ratios where we controlled for the variables used in the matching procedure. Unsurprisingly, given the relatively few deaths, several of the estimations using a 1-month sample did not converge. Supplementary Table 2 shows that the adjusted odds ratios were very similar to the unadjusted ratios.

To further test the robustness of our findings, we also estimated the average treatment effect on the treated. Supplementary Table 3 reports the incremental difference in probability of death for the affected group relative to the comparison group derived from this approach. For instance, 0.763% (1,300 out of 170,328) of the postmatched comparison group died of any cause during the 1-month observation period. The corresponding estimate of 0.003034 in Supplementary Table 3 indicates that a subject in the affected group was 39.8% more likely to die based on the average treatment effect (0.003034/0.007632 = 0.398). This estimate coincided closely with the estimated odds ratio of 1.395. The all-cause estimates were also very similar for the other observation periods. The only significant difference in the by-cause estimates was that the average treatment effect translated to an ~76% greater probability of death due to

Table 3—Mortality odds ratios for affected subjects in the postmatched population

	1 month	6 months	1 year	3 years	5 years	Full period
All (*n* = 170,328)						
All cause	1.395 (1.298; 1.155)	1.152 (1.118; 1,187)	1.132 (1.107; 1.158)	1.087 (1.070; 1.104)	1.083 (1.067; 1.098)	1.100 (1.083; 1.116)
Diabetes	1.077 (0.837; 1.386)	0.965 (0.871; 1.069)	0.911 (0.845; 0.983)	N/A	N/A	N/A
Heart disease	1.348 (1.206; 1.508)	1.174 (1.122; 1.229)	1.146 (1.107; 1.186)	N/A	N/A	N/A
Nephritis†	1.574 (1.091; 2.273)	1.196 (1.023; 1.398)	1.258 (1.124; 1.409)	N/A	N/A	N/A
Did not move to different county, all cause (*n* = 161,729)	1.401 (1.303; 1.508)	1.140 (1.105; 1.175)	1.119 (1.094; 1.146)	1.073 (1.055; 1.090)	1.068 (1.053; 1.084)	1.083 (1.066; 1.099)
Moved to different county, all cause (*n* = 8,599)	0.951 (0.695; 1.300)	1.281 (1.131; 1.452)	1.242 (1.129; 1.366)	1.262 (1.180; 1.349)	1.286 (1.280; 1.369)	1.405 (1.312; 1.503)
Moved to affected county, all cause (*n* = 4,312)	1.095 (0.719; 1.668)	1.414 (1.189; 1.680)	1.298 (1.137; 1.482)	1.361 (1.239; 1.496)	1.459 (1.334; 1.594)	1.570 (1.423; 1.732)
Moved to unaffected county, all cause (*n* = 4,287)	0.886 (0.544; 1.442)	1.216 (1.010; 1.463)	1.257 (1.094; 1.444)	1.183 (1.075; 1.303)	1.153 (1.054; 1.260)	1.315 (1.195; 1.446)

Estimates based on conditional logit regressions where each cell contains the estimate of a separate regression. Moved status is based on the subject's year-end 2004 and 2005 addresses. Affected counties are those designated by FEMA as receiving individual assistance following Hurricane Katrina or Hurricane Rita. Observation periods begin on 28 August 2005. Full sample corresponds to period through 31 December 2014. N/A, estimates not available, as cause of death data were only available for the 1st year of the observation period. †Includes nephritis, nephrotic syndrome, and nephrosis.

nephritis, whereas the odds ratio estimate was 1.574.

CONCLUSIONS

We performed a retrospective study of administrative data to assess the potential mortality effects of Hurricanes Katrina and Rita on seniors with diabetes. Rather than basing this on diagnostic codes from a single encounter (1), we used an algorithm developed by the U.S. Centers for Medicare and Medicaid Services to identify individuals with diabetes. Our use of administrative data improved upon survey data, which can be affected by recall bias. Further, Medicare data are well suited to track individuals over time. Unlike in previous pre- and post-studies (10,11), our use of a plausible comparison group implied that our estimates were unaffected by time trends. The matching technique used to identify the comparison group employed a rich array of variables, including chronic condition indicators that reflect health status.

While in the prematched population the treated and comparison groups were largely similar outside of racial characteristics, our matching procedure resulted in an even closer fit. The analyses of overall mortality indicated a significant initial increase in mortality for the affected group. The crude mortality rate for the 1-month observation period for the comparison group was nearly 40% higher than for the comparison group. The difference almost exactly coincides with the corresponding odds ratio estimate of 1.395. However, the initial effect appears to have dissipated over time. For the full observation period, the crude mortality rate for the affected group was only 6% higher. The crude mortality rates and odds ratios both generally fell as the observation period increased. Our results of an initial increase in mortality are consistent with previous studies of all seniors following Hurricane Katrina (25–27). However, our estimates contrast with a study of dialysis patients that did not detect mortality effects from the storm (13).

Our estimates may partly reflect interruptions in care that later manifested in increased mortality. For instance, in the 3 years following Hurricane Katrina, older individuals with diabetes who lived in affected areas were less likely to obtain cholesterol, HbA_{1c}, and microalbumin screens (14). Dialysis patients faced challenges obtaining care following Katrina due to problems with dialysis unit function and supplies (28). Care and medication interruptions are associated with higher emergency department visit and hospitalization rates over the following 5-year period (8). This relationship may help explain that seniors with diabetes in areas affected by Superstorm Sandy had higher rates of emergency department utilization (29), while 3 years after Katrina, affected seniors with diabetes had more emergency department visits and inpatient admissions (30). It seems likely that the effects of disasters may go beyond emergency department visits and hospitalizations and may partially explain our findings regarding mortality. Further analysis is needed to investigate the extent to which other types of care (e.g., provider visits, medications) to seniors with diabetes are disrupted following weather disasters. Nonetheless, when viewed in the context of previous research, our estimates suggest that mortality may be reduced by ensuring that those affected by disasters are able to improve care adherence even years after the disaster.

Our analysis of by-cause mortality was limited to short-term effects due to the 1-year duration of available data. For heart disease and nephritis, we observed a pattern similar to our all-cause mortality estimates. The 1-month crude mortality rates for the two conditions were 35% and 58% higher for the affected group, respectively. When the observation period was extended to 1 year, the crude rates fell to 14% and 28%. For diabetes, the odds ratio did not differ from 1 for the 1-month and 6-months observation periods, while for the 1-year period the ratio was <1.

The effects of displacement due to disasters are of high interest. Unfortunately, we were unable to identify individuals who moved due to the storms. However, our proxy for displacement, whether an individual lived in a different county after the hurricanes, arguably caused us to underestimate the effects by including those who did not move under duress. The mortality odds ratio corresponding to the 1-month sample was lower for those who moved to a different county than those who did not. However, those who moved and died very soon after the hurricanes likely did not have a revised address; thus, we were less confident in these results. For the other observation periods, the odds ratios for those who moved were greater. Further, the ratio increased considerably when the observation period was extended from 5 years to the full period. Stratifying the affected individuals who moved by whether they moved to a county that was also designated as Individual Assistance provided further potential insight into the effects of displacement. The odds ratios for those who moved to an affected county were larger than for those who moved to an unaffected county. These estimates are consistent with a prior study that found that Katrina evacuees who moved to low-mortality regions experienced lower mortality than evacuees who moved to high-mortality regions (22).

While our data do not allow for definitive explanations regarding the divergence in estimates for those who moved to a different county, several potential explanations are possible. Our finding that the odds ratios were lower for those who stayed than those who moved may have reflected that, on average, those who did not move may have been able to maintain their support and provider care networks. It may also have reflected selection bias in that those who did not move experienced less of an effect from the hurricanes, either by chance or due to a more protective environment. Bias may have also been introduced due to those who did not move having greater resources to recover and thus experiencing lower mortality.

Yet, our analysis that subset those who moved by whether they moved to an affected county suggested that the destination to which the individual moved had a significant impact on their mortality risk. Those who moved to other affected areas experienced significantly higher mortality rates. However, again, selection bias may have played a role in these estimates, insofar as those with higher mortality risk were potentially more likely to move to an affected county, perhaps due to cost.

Our analysis had several significant limitations. We only examined the extreme outcome of mortality. Individuals impacted by the hurricanes doubtless experienced other deteriorations in health that our study did not measure. Our county-based designations of affected and displaced were imprecise.

There was significant within-county variability in impact that our affected variable did not reflect. Additionally, our analysis treated all unaffected counties as being equally removed from the storms' effects. It is likely that some counties in the unaffected group were impacted by the storms and the subjects in those counties are imperfect control subjects for those in the affected counties due to their varying contextual characteristics (31). Future research may explore this aspect by classifying unaffected counties into subgroups based on their distance from the storms' paths and investigating differences between the affected group and the various unaffected groups. Further, our measure of displacement did not account for individuals who moved within the same county and did not reflect whether an individual moved out of duress from the storms' impact.

We also were unable to distinguish between the type of diabetes that the individual had. Given the critical need for timely insulin therapy for those with type 1 diabetes, it is possible these individuals experienced higher short-term mortality than those with type 2 due to a lack of insulin access. Thus, if either the affected or comparison group had a higher proportion of subjects with type 1 diabetes than the other group, their short-term mortality estimates may have been biased upward.

Our data source limited our analysis to those individuals who did not move outside our four-state sample area during the observation period. Further, our sample did not include individuals who were enrolled in Medicare Advantage at any point during the observation period. This did not only result in the loss of roughly 25% of our sample subjects; the relatively better health of this population (32) suggests that our estimates may have been significantly affected if these individuals were included. The identification of chronic conditions was imperfect, as "rule out" claims from laboratory and diagnostic tests may have been inaccurately classified as evidence of the condition, and thus the corresponding prevalence may have been overstated. However, for many conditions this concern was mitigated due to the requirement that multiple qualifying claims be present to establish that an individual had the condition.

Summary

Our retrospective cohort analysis provided estimates of the mortality effects of Hurricanes Katrina and Rita on seniors with diabetes. We found, for those affected, a significantly higher level of mortality not only immediately following those storms but also nearly 10 years later. Our estimates suggested that those who moved following the hurricanes were at higher risk and that the risk was heightened for those who moved to other impacted areas. Our findings highlight the need to ensure that appropriate care is provided to disaster victims immediately after the event as well as in the weeks and months that follow.

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